Energy and environment in Brazil

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Foreword: renewable energy sources and sustainability

Energy, air and water are crucial ingredients to human life. In the primitive societies their cost was close to zero. Energy was obtained from the forests' woodfuel, both for heating and domestic activities, such as cooking. Gradually, however, energy consumption began to increase so much that other sources became necessary. During the Middle Ages, both energy from water courses and the wind were used, but in insufficient quantities to fulfill the needs of growing populations, mainly in the cities. After the Industrial Revolution, it became necessary to use more coal, oil and gas, which are expensive to produce and transport to the consumer centers.

Water consumption has also increased considerably. Thus it became necessary to charge for its use to pay for its purification and transportation costs to the consumers. If, and when, a colony from Earth is installed on the moon (which has no atmosphere), it will be necessary to pay – and very much so – for the air consumed by human beings, that will have to be taken there.

In 2003, when the world had 6.27 billion people, the average total energy consumption was 1.69 ton of oil equivalent (toe) *per capita*. One ton of oil is equal to 10 million kilocalories (kcal), and the average daily energy consumption is 46,300 kcal per person. For comparison sake, it is worth mentioning that 2,000 kcal is the energy that we get from food and that allows us to stay alive and working fully. The remaining energy is used in transportation, domestic and industrial expenses and waste in the energy transformation processes.

The current energy production and consumption patterns are based on fossil sources, which generate local pollutants emissions, greenhouse effect gases and put at risk the long term supply in the planet. Such patterns must be changed, stimulating renewable energy sources. From that point of view, Brazil has a very favorable condition as compared to the rest of the world. Table 1 shows the percentage contribution of the several energy sources to total energy consumed in Brazil and in the world in 2003.

Table 1
Primary energy in Brazil and in the world in 2003,
total and portions according to data from the International Energy Agency (IEA)

Primary energy				Brasil	Mundo
Total, billion of toe				0,193	10,7
Share of the sources (%)	Non-renewable	Fossil	Oil	43,6	35,3
			Natual Gas	6,6	20,9
			Coal	6,8	24,1
		Nuclear		1,8	6,4
			Subtotal	58,7	86,6
	Renewable	Traditional	Traditional biomass	19,0	9,4
		Conventional	Hydro	15,3	2,1
		Modern, "new"	Modern biomass	6,9	1,2
			Other: solar, wind, etc.	< 0,1	1,7
		Subtotal		1,3	14,4

Renewable energy sources represented 41.3% of total consumption in Brazil, while that ratio was only 14.4% in the world. Average energy consumption in Brazil is 1.09 toe per person per day, just below world average. Average consumption does not represent adequately what happens in the world: in Bangladesh it is eleven times lower, and in the United States, five times higher. Total energy consumption in Brazil in 2004 was approximately 216 million toe (Mtoe), or 2% of world consumption, which was 11,223 Mtoe.

Brazilian electricity matrix has a strong hydraulic base (Box 1). However, the stimulus to other "modern" renewable energy sources is still very low compared to world average, despite the Federal Government's efforts through the Program for Investments in Alternative Sources of Electric Energy (Proinfa).

Box 1 – Electricity

ELECTRICITY GENERATION in Brazil had an average annual growth ratio of 4.2% between 1980 and 2002. Hydraulic power has always been dominant, since Brazil is one of the richest countries in the world in terms of hydro resources. In turn, coal has had a modest contribution, since the country has few reserves and their quality is poor.

The installed hydroelectric capacity is approximately 70,000 megawatts (MW, million watts) and there are 433 hydroelectric power plants in operation. Of those, 23 have a capacity higher than 1,000 MW and represent more than 70% of the total installed capacity. There is still considerable potential – approximately 190,000 MW not being used, mainly in the Amazon region, and, therefore, far from the great consumer centers located in the Southeast. The production cost of 1 kW in a hydroelectric power plant is approximately US$ 1,000. The potential for retrofits of the great power plants which were built more than twenty years ago (with installed capacities mainly between 1,000 and 8,000 MW) is 32,000 MW. This can be obtained at a cost of US$ 100-300 per installed kW. Therefore, it is significant.

Among other technologies used for electricity generation in Brazil there are thermonuclear, natural gas and diesel oil thermoelectric power plants, but none of them contribute with more than 7% of the total. The introduction of biomass, nuclear energy and natural gas reduced the percentage of hydroelectricity from 92% in 1995 to 83% in 2002. Electricity generation through biomass (vegetable residues and sugar cane bagasse) in 2002 came from 159 power plants, with installed capacity of 992 MW, or 8% of the thermal electrical power in Brazil. The great majority of these power plants (with close to 952 MW) is located in the State of São Paulo and uses sugar cane bagasse, a by-product of the sugar and alcohol production.

Proinfa was created by Law n.10.438/2002. Its goal was to stimulate electricity generation by wind sources, biomass (such as sugar cane bagasse and landfill gas) and small hydro plants. Proinfa's first phase establish the generation of 3,300 MW through these sources. Its second phase established a 10% goal of these same sources in the entire Brazilian electric matrix in twenty years, but it was abandoned. Law n.10.762/2003 reviewed Proinfa and does not mention Phase 2.

Besides, Brazil is a world paradigm for its vigorous modern biomass program as far as transportation based on ethanol is concerned (Box 2). The consumption of fuelwood, a traditional biomass source, is still high.

Box 2 – Biomass

A specific characteristic of Brazil is the high industrial development and the application of biomass energy technologies. Some good examples of this are: ethanol production from sugar cane, charcoal from eucalyptus

plantations, electricity co-generation from sugar cane bagasse and the use of biomass in the paper and pulp industries (barks and residues from trees, sawdust, black liquor, etc.). The use of biomass in Brazil is the result of several factors combined, including the availability of resources and of cheap labor, fast industrialization and urbanization rates and the historical experience with industrial applications of that energy source on a large scale. Approximately 75% of the alcohol produced comes from the sugar cane juice (which yields close to 85 liters per tonne of sugar cane). The remaining 25% come from the molasses that results from sugar production (with a yield of almost 335 liters per tonne of molasses). In 2004, total bagasse production was close to 110 million tonnes, which generated a surplus of 8.2 million tonnes for non-energy purposes. The energy products resulting from sugar cane contributed with 13.5% of the Brazilian energy matrix in 2004.

The use of fuelwood in Brazil is still significant, mainly in the charcoal pits to produce charcoal and to cook food in the residences. In 2004, the residential sector consumed approximately 26 million tonnes of fuelwood, which was equivalent to 29% of the production. Consumption has been growing in recent years due to the higher costs of its direct substitute, liquefied petroleum gas (LPG), which is sold in pressurized steel bottles. Almost 40 million tonnes were used in the charcoal production (44% of the production), due especially to the strong growth of the production of pig iron and the substitution of mineral coal. The remaining 17% represent consumption in agriculture and cattle raising, as well as in the other industrial sectors. Fuelwood and charcoal represented 13.2% of the 2004 matrix, 0.3% higher than in 2003.

The relatively comfortable position that Brazil enjoys in its energy matrix may nonetheless be jeopardized since there is a divergence concerning the directions that the country must follow in that area.

Retrospective of energy production and consumption in Brazil and in the world

After the "economic miracle" period, Brazil had a strong decrease in the growth rates of Gross Domestic Product (GDP), of primary energy production and of electricity consumption. In the last thirty years, the growth rate of primary energy production in Brazil has been moving along with that of GDP, but electricity consumption has been growing even faster, due to the country's growing electrification and to the installation of electro-intensive industries, such as the aluminum ones. Table 2 allows us to compare Brazil, the world and the blocks of both industrialized and developing countries.

Table 2

Growth indicators and proportion: GDP, electricity and total primary energy consumption in different periods and regions (IEA, 2006; IEA, 2005; MME, 2006, CIA, 2006)

Indicator	Region	Period				
		1971-1980	1980-1990	1990-2000	2000-2003	2004-2005
(1) Annual DGP grouth	**Brasil**	**8,34%**	**1,57%**	**2,65%**	**1,26%**	**2,28%**
	World	3,77%	2,90%	2,80%	4,97%	4,40%
	Non-OECD	5,41%	2,11%	3,81%	3,82%	nd
	OECD	3,44%	3,07%	2,58%	5,23%	nd
(2) Annual electricity consumption growth	**Brasil**	**11,83%**	**5,90%**	**4,30%**	**1,05%**	**4,24%**
	World	5,18%	3,60%	2,62%	2,72%	nd
	Non-OECD	6,96%	4,81%	2,81%	5,91%	nd
	OECD	4,46%	3,02%	2,53%	0,88%	nd
(3) Annual primary energy production growth	**Brasil**	**5,39%**	**1,78%**	**3,32%**	**1,45%**	**1,75%**
	World	3,05%	1,90%	1,45%	2,02%	nd
	Non-OECD	4,50%	2,93%	1,23%	3,80%	nd
	OECD	2,07%	1,05%	1,64%	0,43%	nd

Sources: (a) MME (2006) Balanço energético nacional (National Energy Balance), www.mme.gov.br; (b) IEA (2006) Key world energy statistics www.iea.org; (c) IEA (2005) Energy balances of non-OECD countries. International Energy Agency, Paris; (d) CIA (2006) The World Factbook http://www.cia.gov/cia/publications/factbook/geos/xx.html.

The traditional model established between 1940 and 1960 defined that state-owned companies, both in the federal and state levels, should be responsible for most of the production and distribution of electricity, oil and gas. Petrobrás, Eletrobrás and countless other state-owned companies were created with that goal in mind, including energy planning.

Such model worked well until the mid-1980's, keeping energy costs low and, therefore, promoting economic development, but it also created serious problems, such as:

1. Artificially low electricity tariffs, as, by the way, the federal government made with almost all public service tariffs on a useless effort to control inflation.
2. The political use of the companies that produce and distribute gas and electricity involving incompetent management and the building of several hydroelectric power plants to obtain political profit without the necessary resources to complete them, which would guarantee a minimum of economic return.

To face such distortions a partial privatization of the system occurred halfway through the 1990's, following the procedure that the Western European countries used earlier:

i. De-verticalization of energy production/generation, transmission and distribution.
ii. The introduction of competition in the energy production / generation, transmission and distribution, as well as free access to the network.
iii. Use of independent regulatory agencies and the privatization of state-owned companies.

Traditionally, the government forecasts deal with the oil sector independently from the electricity one, but that tradition is changing because the gas that Petrobrás produces or imports is an important input not only for residential, industrial and vehicle uses (in which liquid fuel prevails), but for electricity production as well.

The Brazilian regulatory system, with the National Oil Agency (ANP) and the Brazilian Electricity Regulatory Agency (ANEEL) became not much realistic, and strictly speaking, both agencies should be substituted by a single regulatory organ to deal with the energy sector as a whole.

Self-sufficiency in oil and the issue of natural gas for Brazil

In the oil sector, control remains basically on the hands of Petrobrás (despite the presence of multinational companies in the sector), and the efforts were concentrated in seeking self-sufficiency in production, exploring the offshore resources in the Brazilian continental platform (Box 3).

More recently, the state-owned company also began to value natural gas, which used to be a by-product of oil exploration released to the atmosphere in *flares*.

Box 3 – Oil and natural gas

The proven oil reserves in Brazil of 11,243 million barrels, which are equivalent to approximately twenty years of the current production, ensure a comfortable situation for the country both in the short and medium terms. For the OECD countries, the reserves represent close to ten years of their production, while the world average is forty years.

The proven natural gas reserves, of 326.1 billion cubic meters (m^3), are 33% higher than those of 2003 and are equivalent to nineteen years of the current production. For the OECD countries, the reserves are equivalent to almost fourteen years of their production, while the world average is sixty years.

Brazil reached self-sufficiency in oil production in 2006. Between January and September of that year, Petrobrás produced 1.763 million barrels per day, which was 5% more than the year before. The production goal is 1.88 million barrels/day. However, the domestic sales of fuel grew only 2%. The country exports 450 thousand barrels of oil/day. According to the International Energy Agency, oil consumption is expected to grow by 1.1% worldwide in 2006.

Natural gas production was 46.5 million cubic meters per day (Mm^3/d) in 2004, which is 7.5% higher than in 2003. The imports from Bolivia reached 22.2 Mm^3/d, which is 60% higher than in 2003. In 2004, the main use of natural gas remained in the industrial sector, with 20.7 Mm^3/d and a substantial growth of 13.7%. The growth of the use in electricity co-generation was also significant, already representing one-third of the use in generation. The use of natural gas as a vehicle fuel also had a great growth.

Natural gas contributed with 9.4% of the Brazilian energy matrix in 2005, as compared to 3.3% in 1995. In 2003, the government adopted a policy to stimulate natural gas consumption, with the goal of occupying the capacity of the Bolivia–Brazil gas pipeline and of draining off gas from the Campos Basin. The energy was very attractive because of its efficiency, lower emissions and attractive prices. However, in 2006 Bolivia decided to nationalize (that is, turn it state-owned) the gas sector, reviewing its price policies and causing instabilities in the Brazilian market. The current natural gas price corresponds to 56% of fuel oil price, but that proportion is expected to reach 80% (a 42% growth), according to the Brazilian Energy Research Company (EPE). Petrobrás is seeking a solution at the Santos offshore basin, where it is expected to invest US$18 billion in ten years.

As far as oil is concerned, it can be said that the pursuit of self-sufficiency is a traditional policy of the Brazilian energy sector, based on the need to reduce financial expenses with imports. However, as the import problem became less important due to the great domestic oil production, other facts should be taken into consideration. Investment in oil spends most of the available income in the country and its reduction could free resources for other purposes that are economically more productive and that could generate products and services for exports.

Besides, self-sufficiency is not guaranteed in the long-term: the ratio between the proven reserves and current production is twenty years. Even with new findings, investments are always growing. The substitution of gasoline for alcohol contributed significantly to reach oil self-sufficiency, an objective

sought for decades. It is also worth to say that self-sufficiency is physical, not economic: we do not have high quality oil and imports are still necessary. Brazilian oil account had a US$ 3.2 billion trade deficit (the deficit reached US$ 2.22 billion in crude oil alone) until August 2006. The movement reflects mainly the great price increase of oil in the international market, which has cancelled the effects of the domestic production growth. While Brazil paid close to US$ 77.62 per barrel bought abroad in August, the exported barrel was sold by the equivalent to US$ 57.44, a difference of US$ 20.18 per barrel. Petrobrás, that controls 98% of refined oil in Brazil, must import light oil (which is more expensive) to process in its refineries.

Self-sufficiency does not apply to natural gas, although great reserves of that product have been recently identified in the Southeast region. To make its use viable, great investments must be made in its transportation systems (such as gas pipelines and compressors). There is the possibility of using and even expanding the gas supply from Bolivia, where Petrobrás has already made considerable investments as a strategy for Brazil to import gas from that country, but it is necessary to consider its recent political problems. Besides greater volume, there has been an increase in the price of the raw material imported from the neighboring country. The purchases of natural gas from Bolivia reached US$ 986 million in the first eight months of 2006, a 63% increase compared to the same period in 2005.

The definition of the interest in import is not determined only by the supply risk. It must be taken considering economic aspects related to energy and to the development of both countries. In the case of Bolivia, one must consider the country's economic options halfway through the 1990's and decide if it can even neglect its exports to Brazil. The decrease in the gas exports from Bolivia will reduce its development capacity, increasing social tensions and reducing its willingness to import Brazilian products. Importing liquefied natural gas (LNG) from Algeria, Trinidad-Tobago and other countries would be an option to be analyzed, but also a very expensive one.

Brazil depends and will still depend for a long time to come on oil and gas and it must seek alternatives to reduce its consumption.

The restructuring of the national electric sector and its mistakes

The privatization of the electric sector was only partial: it occurred in approximately 70% of the distribution capacity, but in only 30% of the generation. That caused a partial collapse of the planning and the "blackout" crisis in 2001, since the private investors, worried as they were with regulatory uncertainties, kept themselves aloof to new investments. From the year 2000 on, the federal government adopted a new model, the goal of which was to try to reduce the investors' risk. That was made by dividing the electricity generation market into two segments, one of them made up of free consumers

and the other one of captive consumers. The free consumers could choose their suppliers among independent producers through bilateral contracts. The captives would be taken care of by companies that would form a transactions chamber.

That model was changed in 2002 with the creation of the Energy Research Company (EPE), under the Ministry of Mines and Energy. It auctions the ventures that it considers necessary to fulfill the demand in the next five years, based on future demand forecasts. However, EPE forecasts for electricity consumption until 2015 are nothing but a macroeconomic exercise, in which simplistic hypotheses are made about market growth based on GDP growth expectations and demand elasticity. Those studies assume that between 2005 and 2015 the GDP growth rates will be between 4.2% (high trajectory scenario) and 5.8% (low trajectory) per year, with 5.2% per year as a reference scenario, that is, the most probable for growth. All these scenarios are extremely optimistic, considering that the Brazilian GDP is growing by less than 3% per year, as shown in Table 2.

The new electric sector model is based on computer simulations that start from questionable assumptions, which is clearly not working as demonstrated in the last electricity auctions, widely discussed in the Brazilian press. One of the perverse results of those auctions was that most of the energy sold comes from fossil fuelled thermal power plants, which shall not only turn the energy more expensive, but it will also aggravate environmental problems.

In other words, the "new model" of the electric sector is taking Brazil away from its natural path which is the utilization of its abundant hydro potentials, a cleaner and renewable energy source. Thus, there is a clear contrast between environmental sustainability and the alternatives that the "new model" privileged on behalf of urgency. As an example, Table 3 shows the result of the last EPE auction.

Table 3

Result of the energy auction that took place on December 2005

Hydroelectric plants	1008 MW
Diesel thermal plants	225 MW
Biomass thermal plants	97 MW
Natural gas thermal plants	1391 MW
Fuel oil thermal plants	19 MW
Coal thermal plants	546 MW

Source: ANEEL, 2006.

Building coal power plants, a highly pollutant energy source, became a profitable business in Brazil. Besides the units already contracted, EPE has enabled 43 diesel and fuel oil plants for the next auction that took place

on October 2006. That represents 4,070 MW, or 20% of the total installed capacity offered in that auction. Two coal plants are expected to enter the auction with 1,192 MW, even though the quality of Brazilian coal is a problem (Box 4).

Box 4 – Coal

The mineral coal that is used in Brazil has two origins: steam coal (energetic), that is domestic and close to 90% of which is used for electric generation, and metallurgic coal, imported to produce coke, mainly used in the steel industry. Brazilian coal has poor quality with sulfur oxide impurities that can reach as much as 7%. In 2004, mineral coal maintained a 6.7% share in the Brazilian energy matrix, with one-fourth of that total being domestic.

Therefore, it seems clear that Brazil is moving in the opposite direction from history, since the rest of the world is seeking alternatives to reduce the share of pollutant energy sources in their energy matrixes. Besides its contribution to the "greenhouse effect", coal impurities cause a phenomenon known for more than one century in big cities, "smog" – a layer of highly toxic haze which causes breathing problems. Fuel oil also presents the same problems, even though in a lower proportion.

The Brazilian calling is hydroelectric plants and there is still great potential to be explored. That's what happens in the complex of power plants at the Madeira river (6,450 MW, R$ 20 billion in investments) and of Belo Monte power plant (11,000 MW, R$ 7.5 billion), which caused great conflict between the Ministry of Mines and Energy and certain sectors of society, mainly the non-governmental organizations. There is a clear reason for that conflict: the great environmental impacts that projects such as Tucuruí and Balbina presented in the past.

Given the anxiety to approve the projects, considered as urgent by the EPE models, the environmental licensing bodies are often pointed out as obstacles to development, bringing to a halt the construction of hydroelectric plants and making the energy auctions privilege other sources. That is a distorted vision of reality, for several reasons:

- many businessmen (and even governmental sectors) consider environmental licensing as mere formality and forget the constitutional principles and the rule of the law in the country;
- construction often begins before the environmental licensing in the competent bodies is complete;

- many of the environmental impact assessments are incomplete and of poor quality; the interested entrepreneur takes a long time to fulfill the requirements;
- there are macroeconomic aspects, such as high interest rates, that make the entrepreneur privilege projects that are built faster;
- certain entrepreneurs try to speed up the licensing of a project without willing to execute it, only to sell a "ready package".

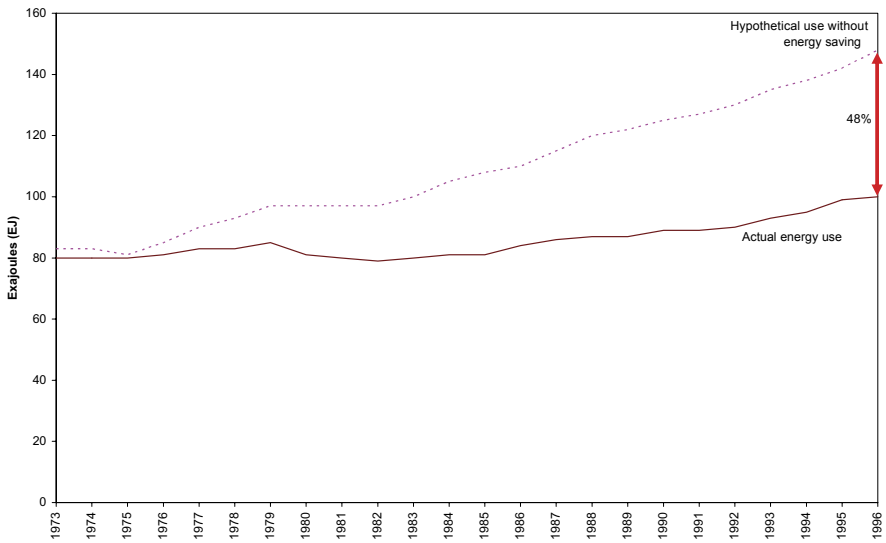
The environmental licensing bodies must find solutions for the complicated permitting process of the hydroelectric power plants – the Brazilian natural calling.

The solution involves environmental compensations, through which the entrepreneurs must allocate at least 0.5% of the total value of his project's implementation costs in the creation of new conservation units or in the maintenance of existing ones. Besides, other measures are indispensable, such as the adequate resettlement of the populations affected by the construction of the power plants.

Postponing these measures is what contributes the most to delay the hydroelectric sector's expansion. It is necessary to seek a balance between the annoyed interests of those affected by the undertaking and the interests of those much larger populations that benefit from it even though they are far away.

Energy conservation in Brazil

The entire energy use rationalization area has not been receiving priority. In the OECD countries, energy consumption would be 49% higher than it currently is if it wasn`t for the rationalization and energy efficiency measures adopted after the oil crises of the 1970`s (Figure 1).



Source: IEA (2005) World energy outlook. IEA, Paris.

Figure 1 – Efficiency gains in the OECD countries, 1973-1998 (IEA, 2005).

In a developing country such as Brazil, *per capita* energy consumption is still low and it couldn`t be expected that energy efficiency measures had so much impact as in the OECD, since energy consumption must necessarily grow to promote development (Figure 2). However, nothing stops the use of modern and efficient technologies from being introduced in the very beginning of the development process, thus accelerating their use. That is the so-called *leapfrogging* effect, which is opposite to the concept that development can only be reached with environmental impacts.

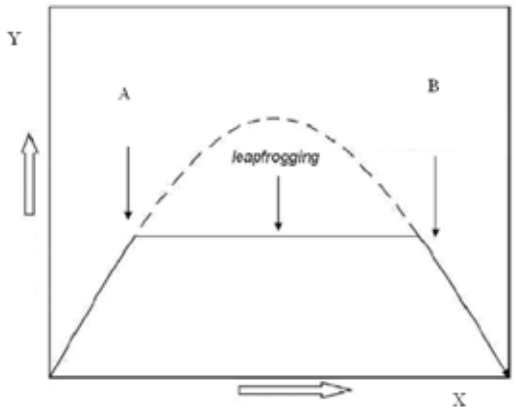


Figure 2 – The Kuznets Curve for the environmental impacts and development phases: (A) from primitive to industrial societies and (B) from industrial societies to information and service societies. In the X-axis there is per capita income; in the Y-axis, income inequalities, primary energy per capita use and the intensity of environmental impacts.

This can be accomplished through policies and actions that are relatively simple and often economically attractive. New and more efficient technologies in refrigerators, air-conditioners, electric motors and lamps are already produced and/or sold in the country. Electricity conservation reduces consumption and postpones the need for investments to expand the installed capacity, without putting in risk the services to the final users. There is no doubt that energy efficiency is the most effective way of reducing costs and both the local and global environmental impacts at the same time. Besides, conservation reduces the need for governmental subsidies for energy production.

Recent estimates made by a group from the University of Campinas (Unicamp) indicate that in the electricity area it would be possible to obtain a 38% reduction in the electricity consumption to be reached by 2020. However, certain cautions must be taken with "models", both those made by EPE and the ones by Unicamp. In the same way that optimistic GDP growth forecasts induce overestimated conclusions about the expansion of electricity generation, prospective scenarios with exaggerated results concerning energy conservation in relation to the current policies get labeled as "wishful thinkings".

When these different visions meet there are often conflicts between the developmentists and conservationists.

That issue must be dealt with through policies that encourage the best forms for energy conservation and generation. Energy planning cannot be a debate between scenarios.

Today, Brazil has two specific programs to promote energy conservation and the rationalization of its use, which are fundamentally aimed at information dissemination and at awareness of the population for the importance of the more efficient use of energy:

- The National Electricity Conservation Program (Procel), coordinated by Eletrobrás and that promotes actions such as education, labeling, municipal energy management, public lightning, electricity management in the industry and in buildings and environmental sanitation; and
- The National Program for the Rationalization of the Use of Oil and Natural Gas (Conpet), coordinated by Petrobrás and that promotes product labeling and transportation actions.

There are, however, two powerful legal instruments that are rarely used nowadays and that could be activated to promote more efficient technologies:

- Law n. 9,991/2000 determines that the concessionaries and permissionaries of electricity distribution public services must make an annual investment of at least 0.75% of its net operational income in research and development of the electric sector and at least 0.25% in programs for the energy efficiency in the final use.
- Law n.10,295/2001 determines that should be established maximum levels of specific energy consumption, or minimum levels of energy efficiency, of machines and appliances that use energy produced or sold in the country, based on pertinent technical indicators.

Conclusion

Future consumption forecasts depend essentially on the kind of development and economic growth that the country will have. For that reason, the several exercises that have been made both by governmental agencies and by university groups reflect different visions of the future and therefore, have different results.

The decisions a country makes concerning energy cannot be based on simple models. The Brazilian energy matrix depends on the path that the economic development of the country will take. There is a growing need for an energy policy that acknowledges that key fact, since part of the energy system was privatized and depends, therefore, on non-governmental investments that will only take place if there are clearly defined rules.

In all cases, the environmental licensing rules must be obeyed. It is possible to mitigate many of the impacts and, with correct policies and a previous and transparent environmental impact assessment, to carry out fair environmental compensations.

Governmental management of the energy sector can be highly increased, since the results of the actions for the greater efficiency in the final use of energy are still modest. Besides, one cannot ignore aspects of security of supply, creation of jobs and environmental sustainability. For example, the use of biomass, besides being commercially competitive with oil, it is cleaner, renewable and permits the generation of many more jobs. The reactivation of Phase 2 of Proinfa, that sets a tangible goal for the new renewable electricity generation sources, is a powerful incentive to the market agents.

Energy efficiency programs, based on the adoption of mandatory standards, stimulate the service sector, reduce pollution and extend the life of the oil and gas reserves. That fact, even though politically relevant and acknowledged, is not explicitly accounted for in the energy expansion programs.

Besides, the definition of the Brazilian industrial profile has a great impact on the quantity and in the type of final energy that we will have to produce. Historically, Brazil is a great producer of products that have an intensive use of energy, such as pulp and paper, iron, steel and aluminum. The change of that profile to products that are less energy-intensive may alter, in the long term, the energy demand in the country and add value to our production and exports.

Abstract – Energy production and use present environmental impacts, but the present consumption patterns can be improved through a more efficient use of energy and a shift from fossil fuels to renewable energy sources. Due to hydroelectricity and bioethanol, Brazil still has a comfortable position compared to the rest of the world. Self-sufficient in oil, the country today discusses how to supply natural gas and electricity in the medium and long terms, with different positions about the path to follow. The present article proposes recommendations, with special focus on the electricity sector.

Keywords: Brazil, Power sector, Policies, Sustainability.

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